Coastal Heritage

VOLUME 30, NUMBER 4 FALL/WINTER 2017-18

Stormwater Ponds

The Coast Re-Plumbed

Contents

3

STORMWATER PONDS: THE COAST RE-PLUMBED

The expansion of engineered ponds as stormwater control devices has changed the way water moves across the coastal landscape, and the effects are still being sorted out.

14

NEWS AND NOTES

- *Susceptibility index designed to safeguard public health*
- *USC President Pastides re-elected Consortium board chair*
- *Cotti-Rausch, Bell chosen for Knauss fellowships*
- Coastal Heritage *captures five awards*

16

EBBS AND FLOWS

- *Southeastern Estuarine Research Society Meeting*
- *South Carolina Hazard Mitigation Conference*
- *Coastal Cultures Conference*

ON THE COVER:

College of Charleston graduate student Sarah Kell scrapes and filters sediments at a stormwater pond on Daniel Island for a microplastics research project.

PHOTO/GRACE BEAHM ALFORD

Sea Grant
S.C. Sea Grant Consortium

Coastal Science
Serving South Carolina

Coastal Heritage is a quarterly publication of the S.C. Sea Grant Consortium, a science-based state agency supporting research, education, and outreach to conserve coastal resources and enhance economic opportunity for the people of South Carolina. Comments regarding this or future issues of ***Coastal Heritage*** are welcomed at Joey.Holleman@scseagrant.org. Subscriptions are free upon request by contacting:

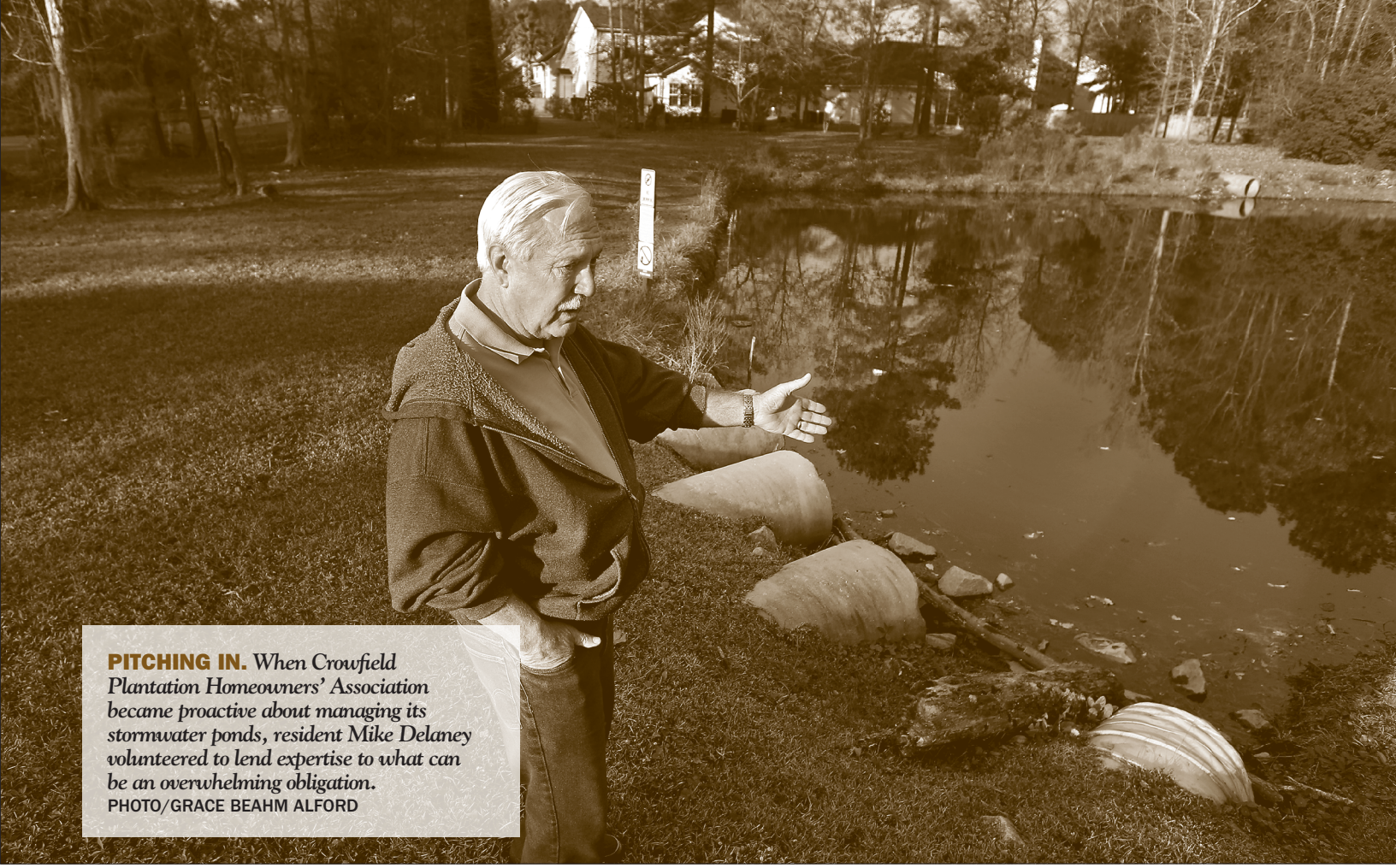
S.C. Sea Grant Consortium
287 Meeting Street
Charleston, S.C. 29401
phone: (843) 953-2078
Joey.Holleman@scseagrant.org

Executive Director
M. Richard DeVoe

Director of Communications
Susan Ferris Hill

Editor
Joey Holleman

Art Director
Pam Hesse
Pam Hesse Graphic Design



PITCHING IN. *When Crowfield Plantation Homeowners' Association became proactive about managing its stormwater ponds, resident Mike Delaney volunteered to lend expertise to what can be an overwhelming obligation.*
PHOTO/GRACE BEAHM ALFORD

Stormwater Ponds
The Coast Re-Plumbed

by Joey Holleman

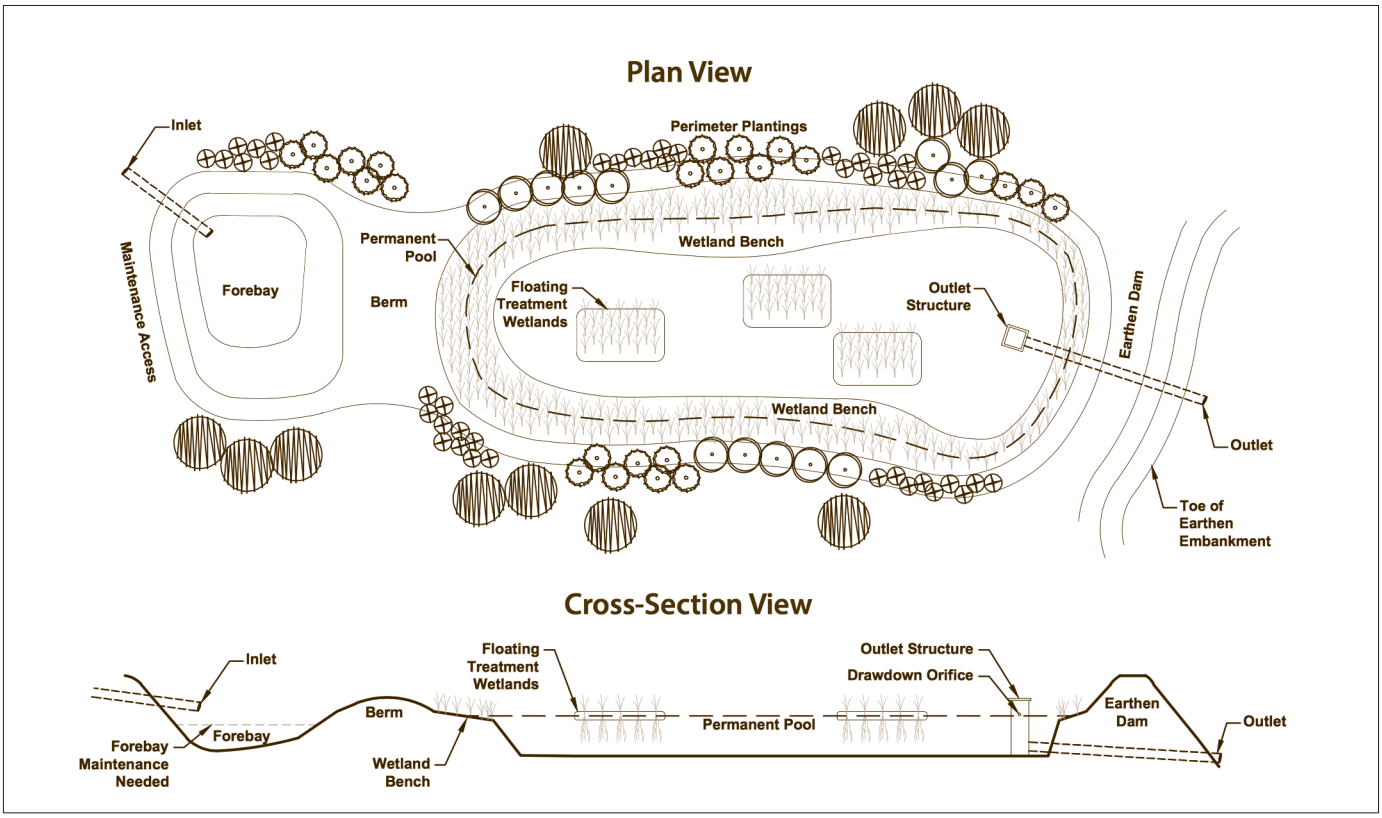
The Crowfield Plantation neighborhood in Goose Creek is typical of large developments built in the past three decades in coastal South Carolina. Hundreds of houses line the streets and cul-de-sacs, and some of the most valuable homes have a much-desired amenity — a water view.

What many of the neighborhood residents are now only beginning to recognize is that amenity comes with a major responsibility. The water features actually are stormwater ponds built by developers not only to look attractive but also to handle rainfall runoff.

Prompted by regulatory changes in the early 1990s, nearly every new residential development built in the past three decades includes a stormwater pond, or more likely multiple ponds. But ponds are not a natural feature in coastal South Carolina's flat landscape. Instead, nature provided swamps and Carolina Bays. Those natural systems perform some of the same services as constructed stormwater ponds, and, with the help of abundant forests to absorb rain runoff, were enough to keep our coastal waterways naturally clean for generations.

But as construction continues to modify landscapes along the coast, developers are required to replace the lost absorption capacity of forests and swamps. Stormwater ponds are the primary design feature used to accomplish that. Builders typically scoop out a low-lying section of their property and guide rain runoff into the resulting pond through pipes or sloped landscaping. The goal is to reduce first-flush flooding during storms and prevent sediment, nutrients, and other pollutants from washing off new roofs, roads, driveways, parking lots, and yards into coastal waterways.

Stormwater ponds, also known as wet detention ponds, are engineered so water enters through pipes attached to roadside drains and flows over the surrounding ground surface. In well-designed ponds, the inlet pipes are lower than an outlet structure similar to the overflow drain in a bathtub. Ideally, pond banks are sloped to increase capacity but not sloped so



ENGINEERED SOLUTIONS. *Stormwater pond design revolves around a main pool that retains rain runoff, but features such as forebays, floating treatment wetlands, and perimeter plantings are becoming more common.*
GRAPHIC/NATALIE CARMEN/NORTH CAROLINA STATE UNIVERSITY

much as to erode when runoff flows over them during heavy rains.

Even well-designed ponds require proactive management to remain effective at what they do. In most cases, developers turn over responsibility of pond management to the resident community once the development is built out. Some homeowners' association (HOA) boards are surprised when the work, and the bills, fall in their lap. And they face fines from state or municipal stormwater agencies if they don't perform maintenance chores such as keeping debris clear of ponds' inflow and outflow pipes or dredging when sediment buildup harms ponds' effectiveness. Even HOA boards that know the responsibility is coming often fail to comprehend what it entails.

In the 3,950-home Crowfield Plantation in Berkeley County, developer Westvaco turned over 41 ponds to the HOA in 2008. The HOA board contracted with a management company for basic chemical control of nutrient buildup for several years before taking a more proactive role. Several board members attended a pond conference put together by Clemson Extension in 2012, and the board paid for a full scientific study of the community's ponds in 2014.

"It's not like we have training in ponds," says April Lipps, manager of Crowfield Plantation HOA. "All of a sudden we had them and had to manage them. We've been feeling it out."

In some ways, so have regulators and researchers. Nearly three decades into the era of regulated stormwater ponds, municipalities are still wrestling with the details of management and the burdens of pond inspection. And while ponds were adopted as a best management practice (BMP) for stormwater management based on scientific theory, researchers still are testing how well those methods work in the unique, real-world geography of South Carolina's coast.

POND CONSTRUCTION OUTPACES POPULATION GROWTH

The idea of slowing down runoff to cleanse water and allow sediments to settle has been around since people gathered in great enough numbers to impact water quality. The ancient Chinese and Egyptians used natural wetlands to clean effluent around their major cities.

By the Industrial Revolution of the 1800s, the more common practice was to pipe rain runoff and sewage straight into waterways. In major rivers, the theory went, dilution was the solution to pollution. By the 1960s, aquatic life was suffering in those waterways. The same heightened awareness about pollution that sparked the first Earth Day in 1970 led Congress to pass the Clean Water Act in 1972.

The legislation had its detractors. President Richard Nixon vetoed the Clean Water Act, citing the cost of

meeting more stringent regulations. The veto was easily overridden, as Congress agreed with Senator Ed Muskie of Maine.

"Can we afford clean water?" Muskie asked. "Can we afford rivers and lakes and streams and oceans which continue to make possible life on this planet? Can we afford life itself? Those questions were never asked as we destroyed the water of our nation, and they deserve no answers as we finally move to restore and renew them. These questions answer themselves."

The Clean Water Act took steps to reduce pollution dumped by pipes straight into waterways, what's called point-source pollution. The new law also addressed sediments and toxins that wash, or run off, into waterways after heavy rains, or non-point source pollution. But non-point source pollution regulations were minimal until Congress passed the Water Quality Act of 1987, prompting stronger state regulation.

In response, South Carolina legislators passed the Stormwater Management and Sediment Reduction Act in 1991, requiring, among other things, design features to retain the additional runoff caused by new housing and commercial developments. While stormwater ponds are the most common of those features, others include vegetated swales, rain gardens, and porous pavement that allows moisture to pass through. During discussion about the new requirements, developers complained about the expense and the potential for development to be constrained.

Instead, development took off, responding to the exploding demand for housing from newcomers. According to United States Census Bureau data, the counties of Jasper, Beaufort, Colleton, Charleston, Dorchester, Berkeley, Georgetown, and Horry were home to 833,519 people in 1990. By 2015, the coastal population zoomed to 1.22 million. That's a 46 percent increase in 25 years.

While accurate numbers for ponds in the entire South Carolina coastal plain in 1990 aren't available, a 1994 survey documented 1,174 east of U.S. 17, the major highway that bisects the region. In 1999, an aerial survey of the state's coastal watersheds — both sides of U.S. 17 — spotted 8,100 ponds.

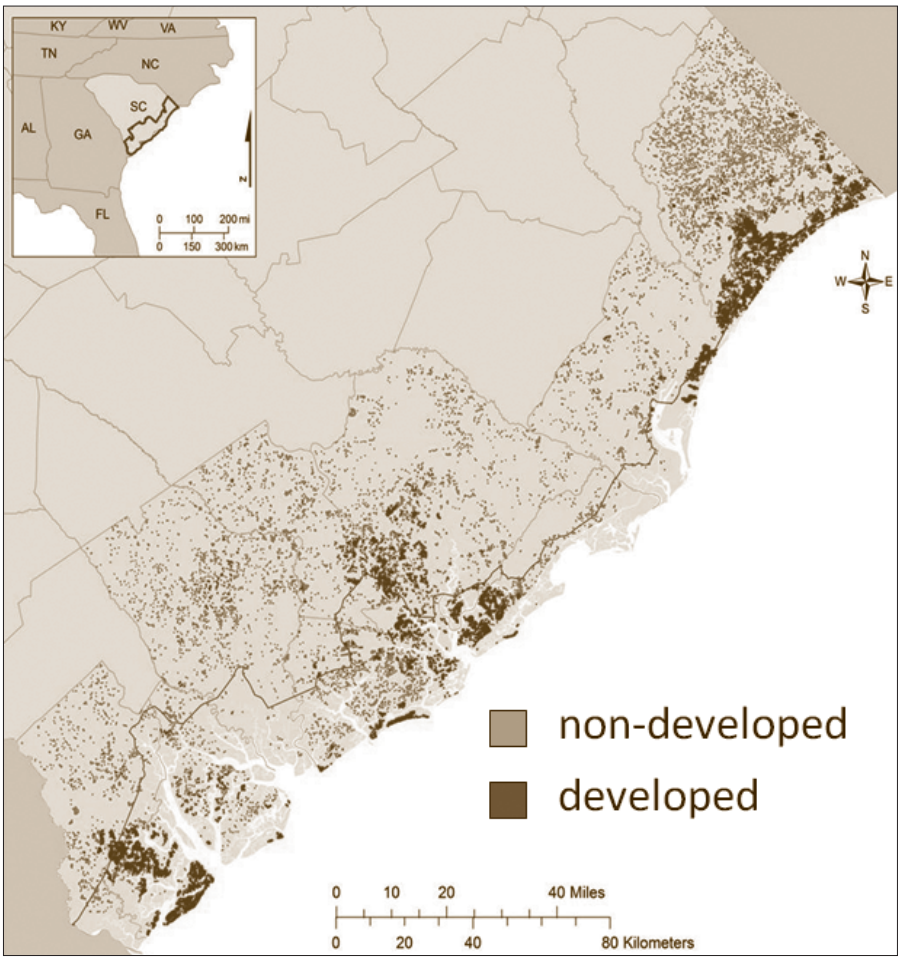
More recently, a research team led by Erik Smith, research coordinator at North Inlet-Winyah Bay National Estuarine Research Reserve and research assistant professor at University of South Carolina, completed an inventory from 2013 satellite maps. They came up with 21,594 ponds in the coastal counties.

The researchers determined 9,269 of the ponds covering 11,916 acres were related to coastal development, mostly residential subdivisions. The vast majority of the other ponds were built for agriculture or fishing and hunting on private properties.

"The proliferation of ponds has amounted to a re-plumbing of the hydrology, changing the way water flows along the coast and what that means for good or for bad to our coastal receiving waters," Smith says. "The short answer is it's both good and bad. It's safe to say ponds now are a major feature of our coastal zone, and there's an intimate link between our ponds and receiving waters."

RESEARCHERS BUILD POND KNOWLEDGE

Examining the role played by stormwater ponds in the state's coastal landscape has kept South Carolina's



PONDS PROLIFERATE. *Researcher Erik Smith and his team used satellite imagery to identify more than 21,500 ponds in coastal South Carolina, and this map indicates where those were associated with development or with farms and hunting property.* MAP/ERIK SMITH/UNIVERSITY OF SOUTH CAROLINA/NORTH INLET-WINYAH BAY NATIONAL ESTUARINE RESEARCH RESERVE

research community busy for the past two decades. A state-of-the-knowledge report being compiled by S.C. Sea Grant Consortium pulls from hundreds of studies and government agency reports.

The trend toward construction of stormwater ponds also is on the rise in Australia, Canada, northern Europe, and China. In the United States, stormwater ponds have been built in every state, though conditions in the desert Southwest and West often lean toward basins called dry ponds, which only fill after rare deluges. Wet detention ponds need water flow to function properly, so they are more common in regions with frequent rain and/or shallow water tables. Even in South Carolina's interior, various dry pond designs are more common than wet ponds, according to Jill Stewart, director of S.C. Department of Health and Environmental Control's Dam Safety and Stormwater Permitting Division.

Throughout the United States, the rise in pond construction has followed development trends, says Bill Hodgins, senior water resources engineer with the Center for Watershed Protection.

"Florida was very early in the trend, though that was driven more as amenities for developments than as protection for wetlands," Hodgins says.

Florida also was an early hotbed of stormwater pond research, helping establish a foundation at the University of Florida on the subject. But recent research performed in South Carolina is more applicable to local conditions for pond builders, managers, and regulators.

Researchers brave biting insects and the occasional alligator to pull water and sediment samples from ponds selected based on size or location. They test the water and sediments for salinity, acidity, trace metals (lead, copper, cadmium, zinc), inorganic chemicals (nitrates, phosphates), pathogens (coliform bacteria, *E. coli*), microplastic particles, and organic chemical compounds such as polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). When high nutrient levels lead to algal blooms in ponds, researchers test the algae to determine if it's potentially harmful to wildlife.

Researchers also examine how water moves from pond inlets to outlets, what designs best slow flooding or prevent erosion of pond banks, and how quickly ponds fill with sediment. Each pond is its own ecosystem, and each ecosystem has multiple factors at play. The research possibilities are endless.

In South Carolina's coastal environment, with its shallow water table, the recommended pond depth is four

RESEARCH ROUTINE. *Sarah Kell, a College of Charleston graduate student, stirs a mix of pond sediments, water, and salt before passing it through a series of screens designed to sort various sizes of sediment particles.*
PHOTO/GRACE BEAHM ALFORD

to six feet. The ideal size of the pond, however, varies depending on the size of the watershed drained, the vegetative cover in that watershed, and other geographic factors. Smith found ponds ranging in size from less than two-hundredths of an acre to nearly 150 acres, but most coastal ponds are small, with an average size of about half an acre.

In a study completed in 2016, Smith assessed the pollutant removal performance of three ponds in Horry County. The ponds were typical of those built a decade or more ago. Water samples were taken at inlet and outlet pipes and as rainwater flowed across sloped landscapes into the ponds.

All of the ponds efficiently retained sediments and soils that typically sink quickly. Two of the ponds were effective at removing phosphorus and *E. coli*; concentrations of both were three-times higher at the inlet than at the outlet. In the pond that didn't perform well, the outlet structure allowed water to flow too quickly from the pond to allow particle retention. All three of the ponds were found lacking in the ability to remove nitrogen, with concentrations only 1.5-times lower at the outlets than at the inlets.

Smith says the takeaway is that traditional ponds in the coastal plain work rather well at removing sediments, phosphorus, and pathogens, but they are not particularly effective at removing nitrogen. This is especially troublesome because excess nitrogen can lead to algal blooms, unsightly conditions, and foul odors. Aquatic plants on shallow shelves near the pond inlets or buffers of land-based vegetation on the edges of the ponds are some promising design options that might be effective in absorbing excess nitrogen.

William Schroer, a graduate student working with Smith at the University of South Carolina's Belle W. Baruch Institute for Marine and Coastal Sciences in Georgetown, conducted a study of sediment accumulation in 14 ponds in Georgetown and Horry counties. The goal was to determine how quickly ponds fill, and thus how often they need to be dredged. Most national guidelines recommend dredging every 10-15 years or as ponds lose 25-50 percent of their depth. But Schroer found sediment buildup rates were typically less than half a centimeter per year, suggesting some South Carolina ponds can maintain effectiveness much longer without being dredged.

MANY MORE STEPS. *Gathering pond samples is just the beginning, as the dozens of sample bottles from each pond have to be examined back in the lab – in this case looking for microplastic particles – and the data must be processed.*
PHOTO/GRACE BEAHM ALFORD

However, longer periods between dredgings could lead to other problems, as pointed out in research by John Weinstein, interim dean for the School of Science and Mathematics at The Citadel. Weinstein's 2008 study of 16 ponds throughout the coastal plain revealed high levels of polycyclic aromatic hydrocarbons in ponds in commercial areas and in residential ponds draining large areas. The concern is that the pollutants, along with microscopic pieces of plastic, don't all settle in sediments forever. They eventually are flushed downstream.

"Our survey of microplastics in Charleston Harbor [in 2013-2014] found a disproportionately large fraction of tire wear particles," Weinstein says. "We hypothesize that the pathway may be from road to stormwater pond to harbor."

While human activities contribute to many of the problems noted in Weinstein's study, another study found at least one situation where natural areas pump more pollutants into waterways than developed areas. Ponds in the DeBordieu Colony development in Georgetown County had lower levels of *E. coli* than found in nearby watersheds surrounded by forests, according to a 2016 study led by Dan Hitchcock, who works out of Clemson University's Baruch Institute for Coastal Ecology and Forest Science in Georgetown.

Evidence suggests hogs, deer, raccoons, bobcats, and birds in the natural forest and wetlands may create more *E. coli*-laden runoff than the pets in the DeBordieu neighborhoods. Incorporating a large natural wetland, which attracts wildlife, as part of a stormwater treatment project might not help reduce *E. coli* contamination in adjoining waterways.

Another major health concern related to ponds is harmful algal blooms (HABs). While algae growing

Collaborative Brings Pond Experts, Stakeholders Together

S.C. Sea Grant Consortium established the S.C. Stormwater Ponds Research and Management Collaborative in 2013 to fill the information gap on how ponds function ecologically in our coastal region.

The Collaborative engaged experts and stakeholders from throughout the state to begin to:

- Develop a sustainable strategy for construction, use, and maintenance of stormwater ponds to meet both economic and natural resource needs.
- Satisfy stormwater pond information needs and concerns of businesses, communities, industries, and homeowners' associations.
- Gain better understanding about the functionality, durability, benefits, and costs of stormwater ponds.
- Develop innovative engineering and construction practices to improve the function of current and future stormwater ponds.

Leaving grass slightly higher along the banks of stormwater ponds is designed to slow the flow of nutrients from yards into ponds.
PHOTO/JOEY HOLLEMAN/S.C. SEA GRANT CONSORTIUM

With funding from the state of South Carolina and the National Sea Grant College Program, the Collaborative enlisted 22 researchers to compile a state-of-the-knowledge report, which will be published early in 2018.

Partners in the effort include South Carolina's research universities, multiple state and federal agencies, private industries, nonprofit groups, and municipal stormwater management entities.

in South Carolina ponds usually only looks or smells bad, sometimes it can grow out of control and become toxic for people and wildlife. Incidences of HABs have been on the rise throughout the United States, in water bodies ranging from the Great Lakes to stormwater ponds.

Dianne Greenfield, a former University of South Carolina (USC) and S.C. Department of Natural Resources researcher now with City University of New York, recently studied the connection between HABs in five stormwater ponds and the presence of *Vibrio* bacteria in coastal South Carolina. Some strains of *Vibrio* can cause severe gastrointestinal and skin problems in people, either through consumption of contaminated shellfish or exposure of open wounds to contaminated water. Greenfield's study found increased levels of *Vibrio* in ponds with HABs and in waters immediately downstream, but only when waters were warm. During winter months, HABs didn't augment *Vibrio*.

"Considering the continued widespread use of detention ponds in many residential communities throughout the southeastern U.S., this is an issue that should be the focus of considerable future research, especially in light of projected climate change effects," the study concluded.

POND RESEARCH TRANSLATED FOR COMMUNITIES

As scientists continue to learn about the ecological functioning of stormwater ponds in coastal South Carolina, several organizations have assumed the role of passing that knowledge along to pond owners and managers. Clemson University Extension Service established its Carolina Clear program in 2004, in part, to perform that role, says Guinn Wallover, a Clemson University water resources extension agent working out of Charleston.

In addition to providing basic tips on the Carolina Clear website, Clemson staffers offer presentations at HOA meetings, one-day pond manager training sessions, and their Master Pond Manager program. In three years of Master Pond Manager training, 40 professionals have completed the full certificate course and more than 110 have finished the letter-of-completion track designed for pond owners.

Clemson Extension along with nearby National Estuarine Research Reserves, S.C. Department of Natural Resources, S.C. Sea Grant Consortium, and local stormwater management agencies produce regional pond conferences to bring experts to local pond managers and owners. For instance, at the Beaufort County Stormwater Pond Conference in October 2017, attendees heard from professionals about managing weeds, controlling problem wildlife, preventing shoreline erosion, and planning for the financial burden of maintaining ponds. About half of the attendees were representatives of HOAs.

Cory Heaton, a state wildlife specialist with Clemson University, led a group of pond managers at the conference on a stroll around ponds on the USC Beaufort campus. The chain of ponds appears to be doing its job well, and one of the ponds at the end of the chain is filling with sediment. "That's good. That's what it's supposed to do," Heaton says, comparing the ponds to a kitchen trash can. "Now let's clean it out and let it do the work again."

Many of the pond managers at the conference sought advice on reducing algae buildup. Heaton talked about vegetated buffers, but he also is an advocate for biological control by stocking ponds with algae-eating fish such as tilapia.

"Vegetated buffers can't do everything to keep the bad stuff out of ponds," Heaton says. "Most water in stormwater ponds comes from pipes. Stormwater ponds can't be treated like natural ponds."

POND REGULATION FOCUSES AT LOCAL LEVEL

As stormwater ponds have proliferated over the past three decades in South Carolina, a regulatory framework evolved. Regulatory roots stretch back to the Clean Water Act, which created the National Pollutant Discharge Elimination System (NPDES). Under NPDES, large communities are required to set up Municipal Separate Storm Sewer Systems (MS4s) to manage pond construction planning, inspection, and public education. In coastal South Carolina, six counties and 19 municipalities have established MS4s.

Horry County was the first in the coastal region to gain MS4 classification in 2006. Beaufort County came on board in 2015. Colleton and Jasper counties still don't have MS4 status. In the meantime, and in areas where MS4s still aren't in place, the S.C. Department of Health and Environmental Control (SCDHEC) is the main pond regulator. After MS4s are established, SCDHEC still reviews plans and grants permits for new stormwater pond construction, but most of the post-construction regulation and education duties are handed over to the MS4s, Stewart says.

Beaufort County hired Eric Larson as director of environmental engineering and land management in 2013 as it ramped up its stormwater management efforts. At the time, the county had one inspector. Today, it has five, funded by stormwater fees charged to county property owners. Larson says he could use more inspectors, but he has established a coordinated plan to evaluate each of the thousands of ponds in his jurisdiction at least every five years.

The inspectors check to make sure ponds installed since the county enacted its stormwater ordinance in 2016 have been built to standards outlined in construction documents. They also check older ponds, which have to meet less stringent standards from when they were built. Inspectors have the authority to issue written warnings and stop-work orders, and levy fines for poorly constructed or maintained ponds, though enforcement actions are rare.

"We're still doing a lot of hand-holding," Larson says. "Most of the time, with the first warning, they say 'I didn't even know I had to do that.' "

The inspectors examine water quality and whether the ponds meet Beaufort County volume-control guidelines of retaining two inches of runoff indefinitely, requiring the water to be disposed of through infiltration or reuse. While there are no state standards for water quality in ponds, there are strict standards for sediments and pathogens like *E. coli* and coliform bacteria in adjacent open waters. A high reading for those pollutants in a stream can prompt SCDHEC to check nearby ponds. Inspections by Larson's staff seek to spot sedimentation or pathogen concerns to prevent downstream problems before they happen.

Inspections are only a small part of the MS4's role. Larson spends much of his time on education, including

SHARING KNOWLEDGE. *At a pond conference in Beaufort County, Clemson University's Cory Heaton explains how vegetated buffers around ponds can positively impact water quality.*
PHOTO/JOEY HOLLEMAN/S.C. SEA GRANT CONSORTIUM

making presentations at HOA meetings. He says that aspect of his job is much easier in coastal South Carolina than it was at his previous job in Kentucky because waterways are such an essential part of everyday life in Beaufort County.

"I tell them the reason I'm up here talking to you is we all want clean water," he says. "I try to drive home the dollars and cents. Clean water around here is key to tourism dollars, and to shrimp, crabs, and oysters."

POND MAINTENANCE BECOMES BIG BUSINESS

Horry County was out front, adopting a county stormwater ordinance and creating a design manual in the early 2000s. Dave Fuss, a watershed manager with Horry County Stormwater Management, says convincing developers to stress functionality over aesthetics in pond design was among the early challenges. Nearly two decades later, educational efforts are aimed at HOAs.

"If they haven't set aside resources, the prospect of pipe repairs and dredging can be pretty daunting," Fuss says.

The Town of Mount Pleasant, among the early MS4s in 2007, still encounters HOAs with little knowledge of their pond responsibilities.

"We go out and give them a high-level assessment," says Hillary Repik, Mount Pleasant's stormwater manager. "We talk about coming up with a maintenance plan. We don't expect them to come up with $200,000 to make changes right away, but they can find one thing they can tackle at a time."

For instance, the first year after a critical inspection, one HOA cut down pond-edge wax myrtles, which contribute to nutrient problems by shedding leaves into the water. The next year, they paid for dredging. After a few more years of incremental improvements, the HOA will be able to keep the pond functioning correctly with less expensive annual maintenance, Repik says.

Dozens of businesses have popped up to help HOAs and private pond owners with management chores. One of those companies, The Lake Doctors, Inc., started in Florida in 1980 and expanded to South Carolina 15 years ago. As many of the South Carolina ponds have begun to age and need maintenance work, the company's local business has evolved.

"Things have changed rapidly," says Sean Fleming, an aquatic consultant with The Lake Doctors based in the company's Summerville office. "Originally, our work was more about fountains and pond amenities. Now there's more emphasis on bacteria and keeping water quality better. And dredging is more of a big deal in the last few years."

At Crowfield Plantation, the HOA also manages a 75-acre dammed lake, and it recently hired North Carolina-based Dragonfly Pond Works to dredge sediment that had built up around the lake's inlet. Dragonfly uses a sediment removal system that looks like a floating metal dock with a submerged, rotating cutting head that breaks up material on the bottom of the pond. Water and suspended sediments are propelled up plastic pipes into giant fabric tubes on the shore. Water passes through the fabric and flows down the bank and back into the pond, but the sediments build up in the tube.

After drying for several days, the tubes of sediments are used elsewhere as fill dirt or trucked to a landfill. The process is a less intrusive, and less expensive, option to draining a pond and bringing in heavy machinery to dredge.

The developers of Daniel Island in Berkeley County took a different approach than Westvaco did at Crowfield Plantation. They turned over pond management in completed sections of the community to HOAs while continuing to build in other sections of the island. The pond engineers and developers also offer the HOAs guidance on managing existing ponds.

The ponds also were built a foot deeper than typical design guidance to help reduce flash flooding, and inlets

FORTIFYING EDGES. *The Crowfield Plantation Homeowners' Association has installed logs made of packed coconut fiber bound with biodegradable rope to prevent erosion in ponds where winds often push small waves against the banks.*
PHOTO/GRACE BEAHM ALFORD

and outlets are frequently cleared. Tony Woody, vice president of Thomas and Hutton, the environmental engineering firm that designed Daniel Island's ponds, is pleased that no houses and only a few yards in the development flooded during the heavy rains and high tides of the October 2015 storm, Hurricane Matthew in 2016, and Tropical Storm Irma in 2017.

Daniel Island also provides a history of pond construction over the past two decades. The first-built sections of the community feature small ponds typical of 20 years ago, and later-built sections incorporate larger ponds. That change had nothing to do with pond performance; home buyers simply told builders they think large ponds look more natural. But developers are paying attention to changing guidelines. A new pond in a section now under construction features a shallow section at the inflow pipe planted with vegetation, a trendy design feature ideal for capturing nutrients before they reach the main pond.

Many of the changes on Daniel Island reflect the trends throughout the coastal plain. For instance, Fuss says Horry County developers now recognize narrow ponds in the Grand Strand area tend to fill more quickly with sediments, have more bank collapses, and generally create maintenance headaches.

"There's more awareness of improvements in design, and there's more awareness of inspecting and maintaining ponds," says Hitchcock, the Clemson researcher. "Show me a pond that isn't routinely inspected and maintained, and I will show you a pond that will not perform as intended. I think there's a growing awareness about that."

NEIGHBORHOODS CRITICAL IN MANAGEMENT ROLE

In Goose Creek, Crowfield Plantation was fortunate to have a healthy reserve fund built from annual homeowner fees. The community also has knowledgeable residents who volunteer their time to attack the issue. Mike Delaney has graduate degrees in chemistry and engineering, and Bob Davis has a background in civil engineering. They have worked with the community's contracted pond management company to do their own version of research — testing theories while on the front line managing ponds.

Their experience matches some of the scientific findings — sedimentation rates are much lower than generally

TRAPPING MUCK. *Mickey St. Clair of Dragonfly Pond Works helps guide sediments pumped from the bottom of a man-made lake at Crowfield Plantation through fabric bags that act as sieves, collecting the sediment but allowing water to flow back down the bank to the lake.*
PHOTO/JOEY HOLLEMAN/S.C. SEA GRANT CONSORTIUM

forecast, and a mix of shoreline vegetation combined with biodegradable logs made of coconut fiber works wonders in battling shoreline erosion.

But they also have seen results that counter conventional theory. For instance, leaving grass a few inches higher on the edge of ponds hasn't always helped reduce nutrient buildup.

Delaney says the ponds originally "were designed for sediment control, but our greatest fear now is that it's not the sediment that's going to be a big-dollar issue, it's water quality." He worries about stricter regulations on pathogens and harmful chemicals that accumulate in ponds and eventually flow downstream.

The costs of standard maintenance by itself can be overwhelming. Capital reserve consultant Miller Dodson Associates, which helps HOAs budget for ponds, provides estimates for dozens of potential expenses associated with a one-acre pond, ranging from $500 for vegetation-eating tilapia to $400,000 for a full-scale dredging. Large debris removal can burn a $10,000 hole in an annual maintenance budget. Reinforcing an erosional shoreline can run $20,000.

And with all of that, a pond owner can't be absolutely assured a pond is working properly without sampling the water and testing it in a lab.

Alan Warren, founding director of the water quality testing lab at USC Beaufort, thinks future emphasis should include lab and/or field-based monitoring focused on an area's specific concerns. His lab primarily assists Beaufort County and the Town of Bluffton with their MS4 requirements, and to a lesser extent private communities near the university. He's not trying to drum up more work for his lab, which is tapped out handling testing for the Beaufort County MS4s. Warren knows from the results gathered by the now decade-old lab that ponds can't simply be designed and built and assumed to function as intended.

In most of the South Carolina coastal plain, that sort of intensive testing has been done only through research projects, and then only on a very small percentage of ponds. Warren thinks it should be done more often and on a wider scale, and he argues that collecting empirical data to verify a pond's functionality would cost a mere fraction of the expense to design and build it.

"The days of build it and forget it are coming to an end, and that end is very near for areas such as ours where unprecedented growth poses a rise for environmental degradation," Warren says.

BIG RESPONSIBILITY. *This map shows just one section of the expansive Crowfield Plantation development, where the homeowners' association is responsible for maintenance of 41 ponds.*
MAP/KELSEY MCCLELLAN/S.C. SEA GRANT CONSORTIUM

BEST MANAGEMENT PRACTICES CAN GET BETTER

People aren't going to stop moving to coastal South Carolina anytime soon, so the number of stormwater ponds is likely to increase. The direction of pond management, education, and research in the South Carolina coastal plain, however, is evolving.

In terms of management, for instance, Beaufort County has

instituted an incentive program, reducing stormwater fees in neighborhoods that bring old ponds into compliance with newer regulations. "It's a carrot vs. stick approach," Larson of Beaufort County says. "Voluntary retrofitting is the only way to go."

On the education front, larger crowds — most recently more than 100 in Beaufort — show up at each regional pond conference. Crowfield Plantation's Lipps says her group has passed the equivalent of a 101-level college course in ponds and needs a 201-level class now. Clemson's Wallover says the Master Pond Manager letter-of-completion track is the Ponds 201 class.

Researchers Hitchcock and Smith think future studies need to focus less on individual ponds and more on how stormwater is processed through an entire watershed, what is referred to as the treatment train. For instance, how do multiple ponds of different designs, connected with rain gardens, vegetated swales, or even natural wetlands, impact water quality?

"Ponds were the textbook BMP, and it turned out they do the job well," says Smith. "Are they perfect? No. Do they work for all things? Definitely not. But we're retaining a lot of things in those ponds and keeping them from getting into coastal waters. Now we need to determine how can they do the job better."

WORK IN PROGRESS. *Stormwater ponds have become ubiquitous in coastal South Carolina neighborhoods in the past 30 years, and their impact is still being sorted out by researchers, regulators, and homeowners' associations.*
PHOTO/GRACE BEAHM ALFORD

Reading and Websites

Adler, Robert W., Jessica C. Landman, Diane M. Cameron. *The Clean Water Act 20 Years Later*, Island Press, 1993.

Beaufort County Stormwater Management.
www.bcgov.net/departments/engineering-and-infrastructure/stormwater-management

Clemson University, Carolina Clear.
www.clemson.edu/extension/carolinaclear

Environmental Protection Agency, Clean Water Act.
www.epa.gov/laws-regulations/summary-clean-water-act

Gold, A.C., and others. "Water Quality Before and After Watershed-Scale Implementation of Stormwater Wet Ponds in the Coastal Plain." *Ecological Engineering,* August 2017.
www.sciencedirect.com/science/article/pii/S0925857417302562

Greenfield, Dianne, and others. "Temporal and Environmental Factors Driving *Vibrio Vulnificus* and *V. Parahaemolyticus* Populations and Their Associations with Harmful Algal Blooms in South Carolina Detention Ponds and Receiving Tidal Creeks." *GeoHealth*, November 2017.
onlinelibrary.wiley.com/doi/10.1002/2017GH000094/abstract

Horry County Stormwater Management.
stormwater.horrycounty.org/home.aspx

S.C. Department of Health and Environmental Control, Stormwater.
www.scdhec.gov/HomeAndEnvironment/Water/Stormwater

S.C. Stormwater Management and Sediment Reduction Act. 1991.
www.scstatehouse.gov/code/t48c014.php

S.C. Stormwater Pond Research and Management Collaborative.
www.scseagrant.org/content/?cid=896

Schroer, William. "Drivers of Sediment Accumulation and Nutrient Burial in Coastal South Carolina Residential Stormwater Detention Ponds." Master's thesis, University of South Carolina, 2017.
scholarcommons.sc.edu/etd/4227

Town of Mount Pleasant Stormwater Management.
www.tompsc.com/197/stormwater

Weinstein, John E., and others. *Chemical and Biological Contamination of Stormwater Detention Pond Sediments in Coastal South Carolina.* Final project report, 2008.
www.scseagrant.org/pdf_files/sc_stormwater_rpt.pdf

NEWS & NOTES

Susceptibility index designed to safeguard public health

What would be the most pressing public health challenges in Charleston if a Category 2 hurricane were to trudge slowly along the South Carolina coast?

Lessons from recent storms make it clear: Flooding would be a major problem. So that's what utility managers, hospital leaders, and municipal planners focused on recently when they gathered in Charleston to test a new tool developed to help understand public health risks from natural disasters.

A grant from the National Oceanic and Atmospheric Administration's Coastal and Ocean Climate Applications program is funding work on the tool, called a susceptibility index, as part of a broad guidebook on the issue. Researchers and graduate students from the S.C. Sea Grant Consortium, University of South Carolina, East Carolina University, North Carolina State University, and Saint Louis University examined the relationships between water infrastructure and public health in two coastal communities: Charleston, South Carolina and Morehead City, North Carolina.

With some in Charleston still drying out a week after Tropical Storm Irma's 4-foot storm surge hit, local officials at the tabletop exercise compared their recent challenges with the potential problems raised by the fictional 2030 Hurricane Liz created for the engagement.

Sea-level rise could mean tides are 1.5 feet higher than in 2017. Add a couple more feet if the storm coincides with a lunar cycle King Tide. And the storm model put together by Tom Crawford, a geography professor at Virginia Tech, incorporated a prolonged rain event preceding the storm. Sea-level rise, rainfall from the preceding storm, King Tides, and storm surge added 6 to 12 feet of inundation along the coast and on tidal waterways well inland.

Participants at a tabletop exercise tested a susceptibility index designed to help determine how prepared communities are for natural disasters.
PHOTO/JOEY HOLLEMAN/S.C. SEA GRANT CONSORTIUM

Crawford used map overlays to show which critical health facilities would be inundated in the "Hurricane Liz" scenario. Using those maps as a guide, the various groups at the meeting then tested methods for gauging the susceptibility of infrastructure to inundation and damage.

The process includes questions about current readiness of utilities, health-care facilities, and municipal governments. Are sewage pump stations designed to keep working when inundated? Do hospitals have plans for getting workers to their facilities if the buildings are surrounded by water? Are municipalities equipped to spray for mosquitoes when the roads are still flooded days after a storm?

Based on answers to the questions, the susceptibility index provides a rating on a 1 to 5 scale and a list of best management practices that could help them improve their score. However, participants in the exercise felt the real value is that the process prompts self-evaluation.

"These questions are a lot to move through, but they're interesting to think about," said Connie Banegas, director of asset management for the Charleston Water System.

"This would be useful not just as an exercise but as a tool for planning," said John Simkovich, preparedness coordinator with the S.C. Hospital Association.

The participants suggested tweaks to some of the questions on the survey. Those suggestions will be incorporated into a final product — a guidebook and susceptibility index that can be adapted for various communities and public health concerns.

USC President Pastides re-elected Consortium board chair

University of South Carolina (USC) President Harris Pastides has been re-elected chair of S.C. Sea Grant Consortium's Board of Directors. Pastides began his second one-year term on January 1, 2018.

Dr. Harris Pastides
PHOTO/UNIVERSITY OF SOUTH CAROLINA

NEWS & NOTES

"My work with Executive Director Rick DeVoe and the S.C. Sea Grant Consortium Board of Directors provides an important opportunity to support sustainable marine resource conservation and scientific research that is beneficial to all South Carolinians," Pastides said.

Pastides, who has been the USC president since 2008, earned his master's in public health and Ph.D. in epidemiology from Yale University. Before becoming USC president, he served as dean of the university's Arnold School of Public Health and as vice president for Research and Health Sciences. Pastides serves on many local, state, national, and international boards, including the S.C. Governor's School for the Arts and Humanities and the Fulbright Faculty Programs.

"I very much look forward to working with Dr. Pastides again this year," DeVoe said. "His leadership and many years of experience working on education and research issues in the state is invaluable to the Consortium's work in meeting the needs of our diverse stakeholders."

Cotti-Rausch, Bell chosen for Knauss fellowships

S.C. Sea Grant Consortium nominees Bridget Cotti-Rausch and Doug Bell have been selected for the Dean John A. Knauss Marine Policy Fellowship, providing them the opportunity to spend a year living, working, and learning in the Washington, D.C. area.

The competitive fellowships are offered by the National Oceanic and Atmospheric Administration's (NOAA) National Sea Grant College Program. Recipients are matched with host organizations in the legislative and executive branches of government.

Bridget Cotti-Rausch **Doug Bell**
PHOTOS/SUSAN FERRIS HILL/S.C. SEA GRANT CONSORTIUM

Cotti-Rausch earned her bachelor's degree in biology from Palm Beach Atlantic University and her master's and Ph.D. degrees in marine science from the University of South Carolina (USC). Her research focused on phytoplankton ecology, and she has studied phytoplankton in a variety of ecosystems, from coastal South Carolina to the North Pacific.

Cotti-Rausch joined the S.C. Sea Grant Consortium as a program specialist early in 2017, helping coordinate the Stormwater Ponds Research and Management Collaborative.

In Washington, Cotti-Rausch will hold a joint position between the non-profit Coastal States Organization (CSO) and the Environmental Protection Agency (EPA) Office of Wetlands, Oceans, and Watersheds. She will integrate the efforts of the EPA with the activities of the CSO, a group that seeks to advance coastal management needs through legislation, funding, and partnerships with federal agencies.

Bell earned his bachelor's degree in ecology and evolutionary biology from the University of Michigan and his Ph.D. in marine science from USC. His graduate focus was on understanding the cycling of dissolved and particulate phosphorous in coastal marine ecosystems.

Bell was selected in 2015 for the Kathryn D. Sullivan Fellowship, awarded by the S.C. Sea Grant and S.C. Space Grant consortiums. Bell also served three years as program coordinator for USC's Research Experience for Undergraduates program. In Washington, Bell will work on policy planning in NOAA's Office of Oceanic and Atmospheric Research (OAR). In addition to being involved in broad-scale strategic planning across OAR, he will assist with individual laboratory evaluations.

The Knauss fellowship program, named for one of Sea Grant's founders, is designed to provide educational experiences to students who have an interest in ocean, coastal, and Great Lakes resources and in the national policy decisions that affect their use, management, and conservation. For more information, visit www.scseagrant.org/content/?cid=56.

Coastal Heritage captures five awards

Communications professionals from throughout the U.S. have acknowledged *Coastal Heritage* magazine in national awards competitions.

The *Coastal Heritage* team's work in 2016 earned a Distinguished Award and Best in Show in the Society for Technical Communication-Carolina Chapter competition, Second Place in the Magazine category in the National Association of Government Communicators Blue Pencil and Gold Screen Awards, the Bronze Award in the Publishing category in the Critique and Awards competition from the Association for Communications Excellence, and an Award of Excellence from APEX.

Sea Grant
S.C. Sea Grant Consortium
Coastal Science
Serving South Carolina

287 Meeting Street
Charleston, S.C.
29401

Connect with us:
www.facebook.com/scseagrant
www.twitter.com/scseagrant

NON-PROFIT ORG
U.S. Postage Paid
Charleston, SC
PERMIT #248

Coastal Heritage is printed on recycled paper using soy-based ink.
www.scseagrant.org

EBBS & FLOWS

Southeastern Estuarine Research Society Meeting

Saint Augustine, Florida
March 8-10, 2018

The Southeastern Estuarine Research Society, a nonprofit educational organization, promotes discussion of current estuarine research and management issues among academics, professionals, and students. Topics for the semi-annual meeting include hydrodynamics, water quality, and education outreach. Visit www.seers.org for more information.

South Carolina Hazard Mitigation Conference

Hilton Head, South Carolina
March 12-14, 2018

The S.C. Association for Hazard Mitigation brings together professionals in engineering, planning, government, private business, and academia to learn about the latest research on managing the problems associated with disasters. Topics covered include floodplain mapping, low impact development, and mitigation grants. For more information, visit www.scahm.org.

Coastal Cultures Conference

Saint Helena Island, South Carolina
April 14, 2018

This Gullah/Geechee Sea Island Coalition event focuses on the impacts of hurricanes and climate change on the sea islands and their residents. Topics include seafood safety, understanding sea-level rise tools, and cultural continuation as climate change impacts the coast. Visit www.facebook.com/events/1761432687498818 for more information.

Subscriptions are free upon request by contacting: Joey.Holleman@scseagrant.org

ATTENTION SCHOOL TEACHERS! The S.C. Sea Grant Consortium has designed supplemental classroom resources for this and past issues of *Coastal Heritage* magazine. *Coastal Heritage Curriculum Connection*, written for K-12 educators and their students, is aligned with the South Carolina state standards for the appropriate grade levels. Includes standards-based inquiry questions to lead students through explorations of the topic discussed. *Curriculum Connection* is available online at www.scseagrant.org/education.

Total printing cost: $1,692 · Total number printed: 5,500 · Cost per unit: $.31